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Rate of sediment deposition and subsequent water storage reduction within Lake Corpus Christi, Texas

by

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Contents

Figures

Table

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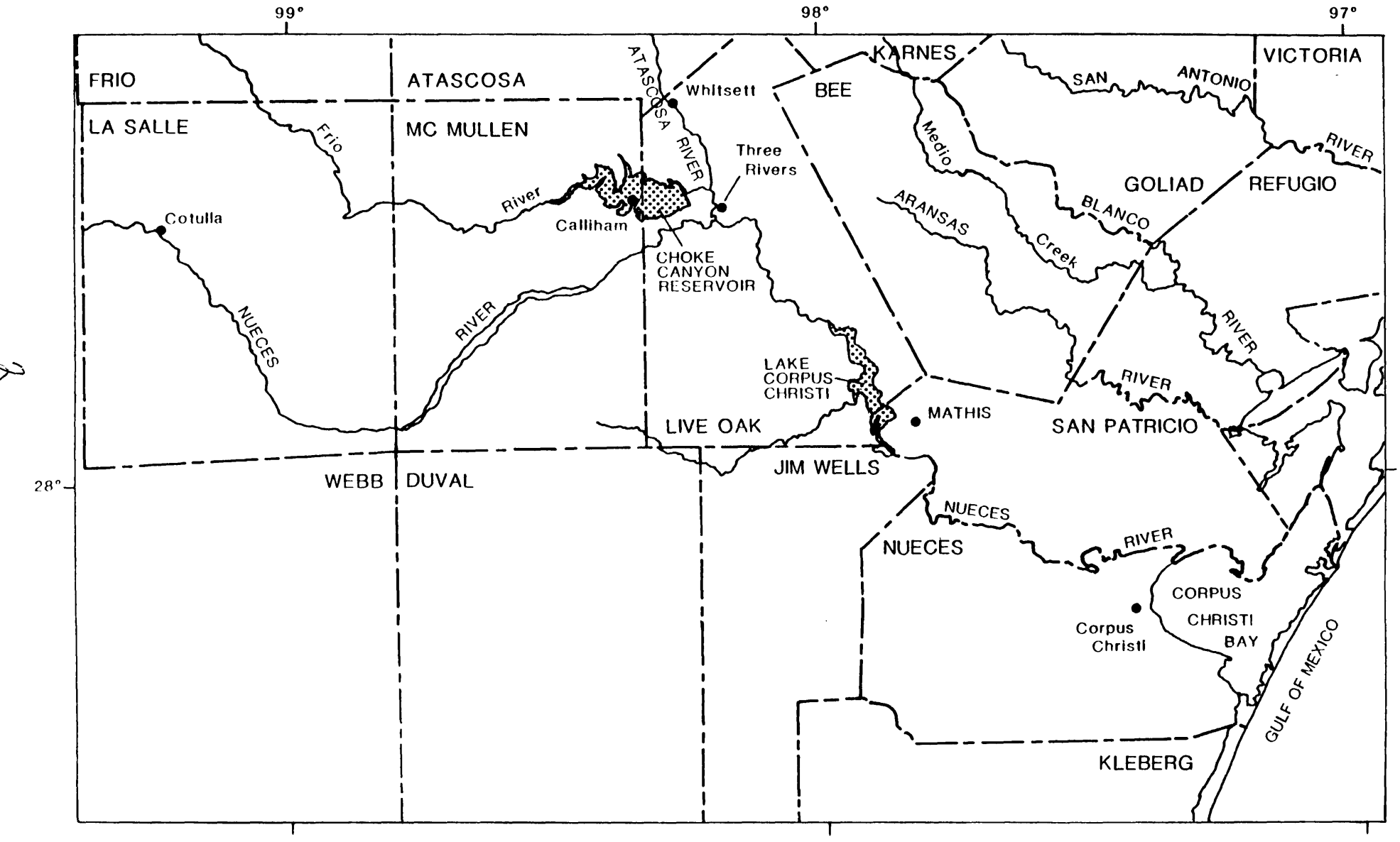
Introduction

A contract between the City of Corpus Christi, Texas, and the United States Geological Survey (USGS), finalized in November 1986, provided for a study primarily intended to determine the amount of the reduction in the water storage capacity of Lake Corpus Christi as a result of sediment accumulation since the last survey in 1972. Lake Corpus Christi has been the source of the city's water supply since the early 1930's when the first dam was built. In 1958 the completion of the Wesley E. Seale Dam increased the useable capacity of the reservoir from 39,397 acre-feet to about 280,000 acre-feet (McCaughan and Etheridge, 1972). The current study indicates that the capacity of the reservoir is decreasing at a rate of 736 acre-feet per year because of sediment deposition. With the recent construction of the Choke Canyon Dam on the Frios River, the future rate of sediment discharge into Lake Corpus Christi will be substantially reduced.

The locations of the Choke Canyon Reservoir, Lake Corpus Christi, and the City of Corpus Christi are shown in figure 1. Lake Corpus Christi is on the Nueces River which, in turn, receives water from the Atascosa and Frio Rivers. The Wesley E. Seale dam, located 4.5 miles southwest of Mathis, maintains a static lake level of 94 feet above mean sea level (MSL) when full.

The specific tasks assigned to the project are as follows:

1. Provide a map of the current lake outline at the 94 foot MSL level.
2. Determine, by bathymetry and sub-bottom profiling, the bottom configuration and distribution of unconsolidated sediments flooring the lake and Nueces River from the Wesley E. Seale Dam on the south to the Beeville Fresh Water Pickup Station as the northern boundary of the survey.
3. Produce a present-day lake bottom sediment distribution map.
4. Produce area-capacity data at 4.0 foot intervals between the 94 and 60 foot elevations above MSL.
5. By analysis of sediment transport records for the 1972-1985 period, provide estimates of the volume of sediment added to the lake during the specified time period.


99°
98°
97°
28°
FRIO
ATASCOSA
KARNES
VICTORIA
LA SALLE
MC MULLEN
BEE
Whitsett
ATASCOSA RIVER
Frio River
Three Rivers
Medio
SAN ANTONIO RIVER
GOLIAD
REFUGIO
Cotulla
Calliham
ARANSAS Creek
BLANCO
CHOKE CANYON RESERVOIR
NUECES RIVER
LAKE CORPUS CHRISTI
MATHIS
SAN PATRICIO
LIVE OAK
JIM WELLS
WEBB
DUVAL
NUECES
NUECES RIVER
CORPUS CHRISTI BAY
Corpus Christi
GULF OF MEXICO
KLEBERG

Procedures and Results

The procedures followed in accomplishing the individual tasks and the interpreted results are discussed in chronological order.

1. An aerial photogrammetric survey of the Lake Corpus Christi storage system was performed by Lammon Aerial Photo Inc. of Corpus Christi, Texas. The individual photographs were compiled into a photomosiac map intended to serve as a guide for future recreational development in the area surrounding the lake as well as to note changes in the lake boundary configuration. A map was produced from the aerial survey for the purpose of establishing a common base for the contour plots of bathymetric and bottom sediment thickness data.

2. The bathymetric and sub-bottom survey was performed by Navigation Management, Inc. of Anthony, Florida. During the survey period (Jan. 21-Feb. 2, 1987) the minimum and maximum levels of the lake were 93.97 and 94.04 feet above MSL, respectively. Two vessels were required for data collection: 1) a large pontoon boat (figure 2) that carried the full complement of positioning systems, computer, echo sounder, sub-bottom profiler, and graphic recorders; and 2) a small skiff intended for use in areas normally inaccessible to the pontoon boat. However, because of the high and stable condition of the lake level, the skiff was only needed near the area known as Swinney Switch (Plate 1). The lines drawn on the lake in plate 1 are the traverses followed in the performance of the bathymetric and sediment thickness surveys. Every tenth shot point is indicated by the dots along the traverses. Survey line miles totaled 446.08 over the lake and 72 in the Nueces River. All depth data were recorded in digital form and stored in the onboard computer for later processing. A graphic recorder was connected to the sub-bottom profiler for real-time display.

The initial compilation of the lake-bottom topography and plotting of shot-point traverses was done by the Moorehead Engineering Company of Ocala, Florida. The data were subsequently transferred to the base map derived from the aerial photo surveys and contoured on four foot intervals (Plate 2).

Surface area and volume calculations were made using a computer program written by Geophysical Techniques Inc. The volume calculation shown in Table 1 considered only the water available at the dam face and excluded the 129.3 acre-feet standing below the level of the base of the dam. Table 1 consists of two parts: 1) the area and useable water capacity calculated from the railroad tracks near Swinney Switch south to the dam, and 2) the area and useable water capacity from the railroad tracks to the point where the Nueces River intersects the 94 foot contour line.


MTX

Table 1.-- Lake surface area and capacity.

Elevation (feet above mean sea level)	Surface Area (acres)	Useable Capacity (acre-feet)
94	18,512	262,536.7
90	18,201	188,715.7
86	15,452.6	119,938.7
82	8,855	86,231.3
78	6,031.8	37,569.5
74	3,565	16,875.7
70	1,404	7,255.7
66	873.2	2,669.3
62	236.3	481.8
58	41.5	84.3
55.5	27.567	0
River surface area and capacity from Swinney Switch to 94 foot boundary		
94	370.94	3,832.4
90	319.01	2,333.9
86	226.50	449.4

3. Dr. Henry Berryhill, consulting geologist of Corpus Christi, Texas, was granted a contract to compile a sediment thickness map (Plate 3) on the beds of the lake and lower Nueces River based on sub-bottom profile data. The Isopach interval is in units of feet. Distribution of the unconsolidated sediments is widely scattered, seldom exceeding 3 feet in thickness. Deposition is greatest at the base of the dam.

4. Water surface area and capacity data at 4.0 foot intervals between the accessible water level and the 94 foot level made from the calculations of Navigation Management, Inc. are shown in graphic form in figure 3. The area-elevation curves comparing the data collected in 1972 by the engineering firm of McCaughan and Etheridge, Corpus Christi, Texas, with the 1987 data suggest that some changes have occurred in the configuration of the lake. Slumping along the shoreline is the probable cause, however, it is possible that regional subsidence resulting from petroleum extraction from the surrounding oil fields also contributes to the apparent changes in the lake configuration. The capacity-elevation curve indicates a decrease in the lake's water storage capacity of about 8000 acre-feet lake as the result of sediment deposition during the 1972-1986 period.

5. Personnel from the Water Resources Division of the U.S. Geological Survey, headquartered in Austin, Texas, were charged with the responsibility of researching all available sediment data for the years 1972-1985. The intent was to compile and update all sediment records, published and unpublished, collected at active and discontinued sediment stations upstream and downstream of Lake Corpus Christi, to determine total and annual rates of sediment deposition for the indicated period of record. Sediment stations used in the analysis were those operated by the Texas Water Development Board on the Nueces River near Cotulla and Mathis, and on the Frio River at Calliham. USGS records were obtained from stations at Whitsett on the Atascosa River, Three Rivers on the Nueces River, and also at Calliham. None of the records span the entire period, therefore regression analysis was applied to the data to estimate the rate of sedimentation for those years in which no records were obtained (Leibrand, 1987).

Summary

The results of the investigation indicate that, in the 14 year period from October 1972 to September 1985, a wet total volume of 10,300 acre-feet of sediment was added to Lake Corpus Christi. The average sediment deposition is approximately 736 acre-feet per year. For comparison, sediment records analyzed for the 1942-48 period by McCaughan and Etheridge (1973) produced an increase of 640 acre-feet per year to the lake sediments. Estimates of sedimentation rates made by the U.S. Soil Conservation Service using bottom profiles for the same period yielded a deposition rate of 736 acre-feet per year. In an analysis of bottom profiles following deposition over the years 1948-72, McCaughan and Etheridge calculated the annual deposition rate at 832 acre-feet.

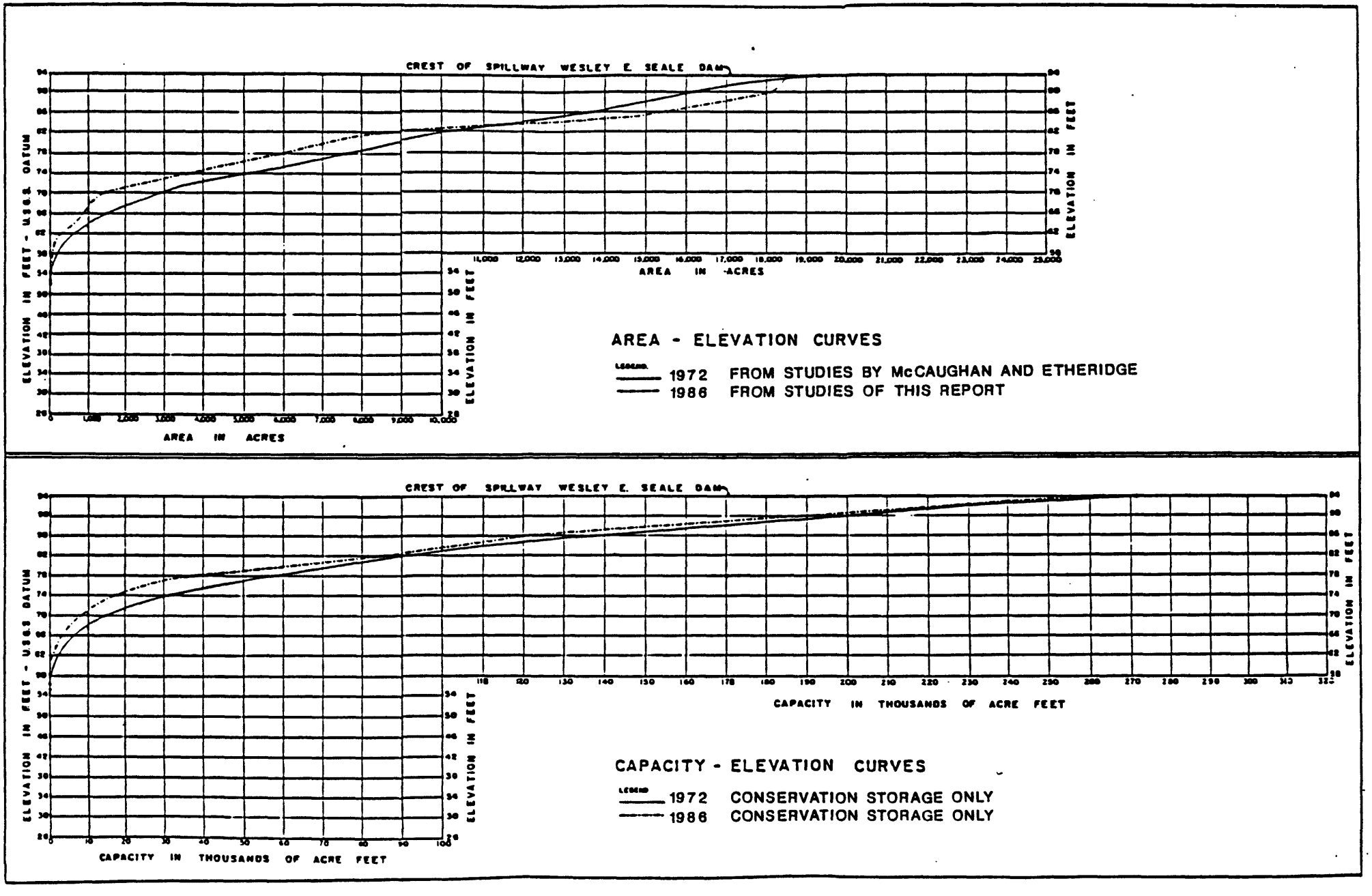


Figure 3. Water capacity and surface area of Lake Corpus Christi plotted as a function of elevation (MSL) as determined from the 1972 and 1986 bathymetric surveys.

References Cited

Leibrand, Norman F., 1987, Estimated sediment deposition in Lake Corpus Christi, Texas, 1972-1985. U.S. Geological Survey Open-File Report 87-239.

McCaughan and Etheridge Consulting Engineers, 1973, Report on sedimentation survey of Lake Corpus Christi for the city of Corpus Christi, October, 1973 with Appendix A by Southwest Research Institute.